APPENDIX A
TOTAL MAXIMUM DAILY LOAD (TMDL)
DEFINITION, PURPOSE, AND CALCULATION

Definitions

A TMDL is defined under Section 75-5-103 of the Montana Water Quality Act as follows:

"**Total Maximum Daily Load** or TMDL means the sum of the individual waste load allocations for point sources, and load allocations for nonpoint sources and natural background sources, established at a level necessary to achieve compliance with applicable surface water quality standards" (MCA 75-5-103 (32)).

A TMDL can also be viewed as a plan, or pollutant budget, establishing the maximum amount of a pollutant that a water body can assimilate (the water body loading capacity) without exceeding applicable water quality standards. TMDLs are often expressed in terms of an amount, or load, of a particular pollutant (expressed in units of mass per time such as pounds per day). TMDLs can also be expressed as the maximum allowable concentration of a parameter, as a required load reduction, or as specific mandates ensuring that water quality standards are met (e.g., no toxic concentrations of sediment metals concentrations).

"**Loading capacity** means the mass of a pollutant that a water body can assimilate without a violation of water quality standards. For pollutants that cannot be measured in terms of mass, it means the maximum change that can occur from the best practicable condition in a surface water without causing a violation of the surface water quality standards" (75-5-103-15).

"**Waste load allocation** means the portion of a receiving water's loading capacity that is allocated to one of its existing or future point sources" (75-5-103-34).

"**Load allocation** means the portion of a receiving water's loading capacity that is allocated to one of its existing or future nonpoint sources or to natural background sources" (75-5-103-14).

Together, the above defined terms along with a margin of safety comprise the TMDL as follows:

TMDL = Loading Capacity = SUM of Waste Load Allocations + SUM of Load Allocations + Margin of Safety

The **margin of safety (MOS)** is included in the TMDL equation to account for uncertainty regarding the relationship between pollutant loads and receiving water quality (CWA 303(d)(1)(C)). The margin of safety is typically incorporated into a TMDL through use of conservative assumptions during TMDL development, referred to as an implicit MOS. An MOS can also be included as a specific amount, or percentage of the total TMDL, referred to as an explicit MOS (EPA, 1999). TMDLs for nonpoint sources typically rely on post-TMDL Implementation Monitoring as an MOS to ensure that the TMDL targets are met. An implicit

MOS, including post-implementation monitoring, has been utilized for the Blackfoot Headwaters Planning Area metals TMDL.

Purpose of A TMDL

A TMDL provides a framework for identification and prioritization of sources and causes of water quality impairment in a watershed, and to direct restoration efforts required to attain compliance with water quality standards and restore beneficial uses. By providing this information, the TMDL serves as a blueprint for water quality restoration planning within all, or a portion of, a watershed. The term *water quality restoration plan* is often used to more effectively describe a TMDL document, such as this one, which presents a TMDL and associated information required for water quality restoration planning.

TMDL Development for Blackfoot Headwaters Planning Area

Section 303(d) of the Federal Clean Water Act requires that TMDLs be establish at a level, which accounts for seasonal variability in water body conditions. For metals, the stream loading capacity, and thus the TMDL, is a function of the streamflow rate (dilution capacity). For certain metals (i.e., cadmium, copper, lead, zinc) the numeric water quality criteria (target metals concentrations for the TMDL) are a function of water hardness. Therefore, the TMDL must be developed in such a manner to ensure that water quality standards are met under any streamflow or water hardness conditions.

In order to accomplish this, the Blackfoot Headwaters metals TMDLs are presented as an equation yielding the stream loading capacity for any given streamflow and water hardness.

TMDL (lb/day) = X (μg/L)(Y cfs)(0.0054)

Where:

X= the numeric water quality criteria in micrograms per liter (parts per billion) for a specific metal adjusted for water hardness as necessary;

Y= streamflow rate in cubic feet per second;

0.0054 = conversion factor.

Throughout this document, flow data is given in cubic feet per second (cfs or ft^3/sec) and concentration data for most pollutants is in micrograms per liter (ug/l), which is the equivalent of parts per billion. The equation identifies the overall loading capacity to the stream under any conditions and at any time.

Water Quality Restoration Targets

Water quality restoration targets are identified in the water quality restoration plan to serve as TMDL goals, or endpoints. For metals in the Blackfoot Headwaters Planning Area, restoration targets consist of numeric water quality targets, aquatic life support targets, and stream sediment targets

Numeric Water Quality Targets

For most metals, water quality restoration targets are based on the numeric water quality standards, or criteria, included in State water quality standards (MDEQ WQB-7). The numeric water quality criteria represent the maximum concentration of a specific metal allowable in State surface waters by Montana law, and are based on protection of intended beneficial uses (i.e., aquatic life support, drinking water supply).

With the exception of aluminum, the water quality restoration targets for all metals in this plan are based on the total recoverable fraction. The aluminum restoration targets are based on the dissolved fraction in accordance with the state of Montana water quality standards (WQB-7).

<u>Water Hardness/Water Quality Restoration Target Interdependence</u>
For copper, cadmium, lead, and zinc (and some other metals), the aquatic water quality criteria are dependent on the water hardness (Reference WQB-7; Note 12). The chronic aquatic life standard equation for these metals is identified below (WQB-7 also provides the applicable equation for acute aquatic life standards):

$$(X\ ug/l) = \exp\{mc[\ln(hardness)] + bc\}$$

where:

X = the chronic aquatic life standard calculated as a function of hardness
mc = constant that varies by metal; values provided in WQB-7;
bc = constant that varies by metal; values provided in WQB-7;
hardness = hardness value in mg/l $CaCO^3$; (use 400 if >400 and 25 if <25)

For aluminum, iron, and manganese, the standard and associated targets are not a function of hardness.

<u>Application of Iron and Manganese Standards</u>
Iron and manganese, unlike cadmium, copper and most other metals addressed in this restoration plan, are not classified as toxins or carcinogens. Consequently, narrative standards have been adopted for these metals to ensure protection of most designated uses as opposed to specific numeric standards. WQB-7 states that concentrations of these parameters “must not reach values that interfere with the uses specified in the surface and groundwater standards”. WQB-7 further states that the Secondary Maximum Contaminant Levels established by EPA (based on protection of aesthetic issues such as taste, odor, staining) of 300 µg/L (micrograms per liter, or parts per billion) for iron and 50 µg/L for manganese may be considered as guidance in determining if a certain concentration interferes with the specified uses. In addition to the general narrative standard, iron has a numeric chronic aquatic life standard of 1,000 µg/L.

For the Blackfoot Headwaters Planning Area, the guidance values stated above were used in conjunction with other anecdotal information to determine if concentrations of iron or manganese constitute impairment of a water body. For instance, in cases where iron and/or manganese exceed the guidance values in a water body, consideration was given to the number of measurements exceeding the guidance values and the level of the exceedence(s). Exceedences of iron can also be less of a concern since iron will tend to be in a particulate (total recoverable) versus dissolved form during higher flows, allowing for some removal via conventional treatment (reference ARM 17.30.623(2)(h)(i)). If the data showed that either guidance value would be exceeded on a consistent basis and exceeded by a significant margin after conventional treatment, the water body was considered impaired for iron and/or manganese. Ultimately, the measure of compliance with the drinking water standards for iron and manganese is based on the need for B-1 waters being suitable for drinking, culinary and food processing purposes after conventional treatment.

For iron, water quality data were also compared to the chronic aquatic life criteria of 1,000 μ/L. Water bodies exceeding the aquatic criteria for iron were considered impaired for the beneficial uses of aquatic life and cold water fish. There is no aquatic life standard for manganese in WQB-7, although potential toxic impacts associated with elevated levels of manganese, as well as iron, in sediment chemistry is considered.

The above approaches for making iron and manganese impairment determinations are also applied toward setting and evaluating compliance with iron and manganese targets.

Aquatic Life Support Restoration Targets

In addition to the numeric water quality criteria, restoration targets in this plan are also based on biotic indicators of macroinvertebrate and periphyton communities. These biota indicators must show no metals-related impediments to full support conditions when compared to a known reference condition as defined in MDEQ's water quality assessment process and methods document (MDEQ, 2002). Reference conditions may be determined by collecting regional reference data from a different water body possessing similar geology, hydrology, morphology and habitat conditions, and exhibiting minimal anthropogenic impacts and/or all reasonable land, soil and water conservation practices having been applied. Reference conditions can also be determined locally through comparison to a different segment of the same water body, such as an unimpaired segment from the same stream, or through comparison to an unimpaired stream segment in the same watershed. Local reference condition development must also consider most or all of the same criteria considered in the development of regional reference conditions.

MDEQ has developed criteria for macroinvertebrates and periphyton that shall be used as targets when a local reference site is not available. The sampling protocols and criteria are documented within Montana's SOP manual in Sections 12.1.2.4 and 12.1.3.3. Targets must use the criteria for the appropriate ecoregion that reflect aquatic beneficial use support conditions. Generally, if a stream is within 75% of the reference condition it is considered to be fully supporting. Although the goal is to be equal to the reference condition, this overall reference condition approach and the use of 75% value accounts for variations in natural systems and analytical methods used to compare conditions in one stream with conditions in another. Where this variability can be reduced, for example under conditions of more localized reference condition information, then a higher number than 75% can and should be used, which is why the 75% value has not been specifically incorporated into any of the targets.

Stream Sediment Metals Concentration Targets

Since there are no numeric limits for metals in sediments as there are for water, a narrative restoration target/criteria is established mandating that stream sediment metals concentrations may not impede beneficial uses (focus is protection of aquatic life). Compliance with this target will be determined through comparison of sediment metals concentrations to published values denoting potentially harmful conditions for aquatic life, in conjunction with biological assemblage sampling to verify if the aquatic life support beneficial use is being achieved. MDEQ will be developing screening level sediment criteria for evaluating potential impacts from stream sediment metals concentrations in the future. Once developed, the criteria will be used to help determine compliance with the restoration target and as an indicator of potential upstream impairment conditions.

Applicable Narrative Water Quality Standards

ARM 17.30.623(2)(h)(i):

> "*Concentrations of carcinogenic, bioconcentrating, toxic or harmful parameters which would remain in the water after conventional water treatment may not exceed the applicable standards set forth in department Circular WQB-7*"

ARM 17.30.623(2)(c):

> "*Induced variations of hydrogen ion concentration (pH) within the range of 6.5 to 8.5 must be less than 0.5 pH unit. Natural pH outside this range must be maintained without change. Natural pH above 7.0 must be maintained above 7.0.*"

ARM 17.30.637(1):

> "*State surface waters must be free from substances attributable to municipal, industrial, agricultural practices or other discharges that will:*

ARM 17.30.637(1)(a):

> "*settle to form objectionable sludge deposits or emulsions beneath the surface of the water or upon adjoining shorelines;*"

ARM 17.30.637(1)(d):

> "*create concentrations or combinations of materials which are toxic or harmful to human, animal, plant or aquatic life;*"

ARM 17.30.602 Definitions:

17.30.602 (17):

> *"Naturally occurring " means conditions or material present from runoff or percolation over which man has no control or from developed land where all reasonable land, soil and water conservation practices have been applied. Conditions resulting from the reasonable operation of dams in existence as of July 1, 1971 are natural.*

ARM 17.30.602(21):

"Reasonable land, soil, and water conservation practices" means methods, measures, or practices that protect present and reasonably anticipated beneficial uses. These practices include but are not limited to structural and nonstructural controls and operation and maintenance procedures. Appropriate practices may be applied before, during, or after pollution-producing activities.

MCA 75-5-103(30):

"Sufficient Credible Data" means chemical, physical monitoring data, alone or in combination with narrative information, that supports a finding as to whether a water body is achieving compliance with applicable water quality standards.